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L. O. HOWARD, Entomologist and Chief of Bureau.

# THE INDIAN-MEAL MOTH AND "WEEVIL-CUT" PEANUTS.

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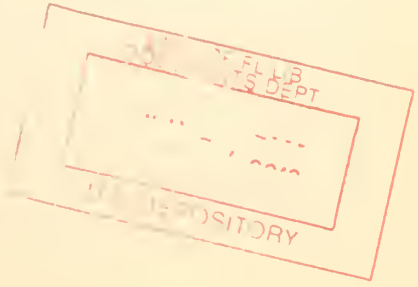

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## THE INDIAN-MEAL MOTH AND "WEEVIL-CUT" PEANUTS.

By C. H. POPENOE,

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Until a few years ago the peanut had been considered as almost immune from insect injury, the plant being affected by few insects, and the "nuts" being protected by their thick shells against most of the usual insect enemies of stored products. There are, it is true, one or two species of beetles which by reason of their horny jaws are able to cut readily through the woody tissue, but the injury from any of these had been infinitesimal.

Since the advent of the mechanical thrasher or "peanut picker" conditions have changed to a great degree. The machinery is by no means perfect as yet, and the tendency of the operator to feed the peanuts too quickly through the machine results in a large percentage of broken shells, and affords easy entrance to several of the common stored-product pests. It is estimated that between 20 and 30 per cent of the peanuts are injured in this manner, consequently becoming "seconds," and in nearly every case becoming infested in a short time after being stored.[1]

Another source of injury to the shells of the peanuts, affording ingress to insects, is the practice of piling the sacked nuts high in

[1] At a meeting held June 14, 1911, at the Department of Agriculture, Washington, D. C., which was attended by many prominent peanut dealers, chiefly from Norfolk, Suffolk, and Portsmouth, Va., and from North and South Carolina, the question of how to treat "cut" peanuts was discussed by Mr. Popenoe and by the writer, and an agreement was reached to undertake the project of testing remedies for peanuts in store. The value of the peanut industry for 1910 was estimated at $15,000,000. Assuming the percentage of insect injury to be the same as that to stored cereals, the loss to the peanut dealers would be 20 per cent, or, at a conservative estimate, $3,000,000. One prominent dealer was about to abandon the industry because of insect injury. In tidewater Virginia, where a preliminary investigation was made, Mr. Popenoe was assisted by Mr. F. V. Johnston and by Mr. W. R. Beattie, of the Bureau of Plant Industry. Indeed, it was owing to the services of Mr. Beattie that this investigation was begun. The accompanying circular is being issued by request of the peanut growers.—F. H. CHITTENDEN.

the storage warehouses. This makes it necessary for the workmen to climb upon the stacks of sacked peanuts, thus breaking many more, and increasing the percentage of infestation.

The insect chiefly concerned in the injury to stored peanuts is the larva of a small dusky moth, commonly called the Indian-meal moth (*Plodia interpunctella* Hbn.), a common and well-known pest, habitually frequenting all places where foodstuffs and cereals may be stored, and feeding, as its name would indicate, upon meal, flour, and grain. It also attacks dried fruits, nuts, chocolate, and seeds. Like other related species, it prefers darkness or semidarkness, although at times seen abundantly in well-lighted storerooms.[1]

## DESCRIPTION OF STAGES.

The adult or moth, shown in the accompanying illustration (fig. 1, *a*), is about one-half to three-fourths of an inch in expanse of wings. The outer two-thirds of the forewing is of a reddish brown color with a coppery luster, while the inner third is whitish gray, giving the insect, while resting, the appearance of being cloaked. The hind wings are dusky gray. The larva, shown at *c*, *d*, and *e*, in the figure, is dirty whitish, varying at times from greenish to a decided pink cast. It is about one-half of an inch in length when mature. The pupa, shown at *b*, is about three-eighths of an inch in length and light brown in color. It is inclosed in a cylindrical silken cocoon or web, which may be mixed with frass. The eggs are small and white, and are deposited upon the food substance selected, either singly or in groups of three to a dozen.

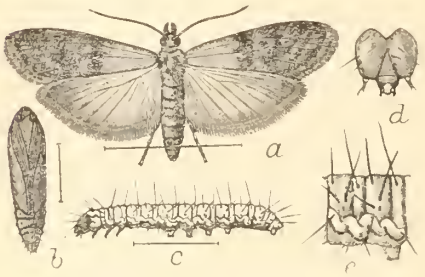


FIG. 1. The Indian-meal moth (*Plodia interpunctella*): *a*, Moth; *b*, chrysalis; *c*, caterpillar; *d*, head; *e*, first abdominal segment of caterpillar, more enlarged. (From Chittenden.)

## LIFE HISTORY AND HABITS.

The moths usually make their appearance in numbers, in Virginia, by about the middle of June, and may be seen flying in the darker portions of the storage houses or resting upon the sacks of peanuts.

[1] In addition to the Indian-meal moth, several other insects are frequently found to injure peanuts in storage. These, in the order of their importance, are as follows: The rust-red flour beetle (*Tribolium navale* Fab.), the saw-toothed grain beetle (*Silvanus surinamensis* L.), the cadelle (*Tenebroides mauritanicus* L.), the fig moth (*Ephestia cautella* Walk.), and the Mediterranean flour moth (*Ephestia kuehniella* Zell.). The three former species are capable of cutting through the shells of peanuts, but rarely occur in such numbers as to be injurious to them. They are amenable to the remedies mentioned in this publication.

In unheated houses the first eggs are laid in March and April by the moths just issuing from the pupal stage. At this time they are comparatively scarce and are little noticed; but later, when the successive generations have been allowed to multiply, they become very abundant, reaching their maximum in the latter part of August. In heated rooms reproduction may be continued throughout the winter.

The eggs hatch in about 4 days after deposition, and the larvæ at once begin the work of destruction. The larval stage may be considered to last about 18 days, varying according to weather conditions. During this time the larvæ crawl from one kernel to another, feeding as they go, and spinning a quantity of silken thread, which, mixed with food particles and excrement, disfigures and injures the material over which they crawl. When the nuts have been attacked for some time the entire mass resembles a mat of webbing mixed with powdered food material and frass. When fully mature the larvæ crawl about, seeking a place for pupation and spinning large quantities of web as they go, finally making, in cracks in the flooring, between bags, or in other dark places, cylindrical silken cocoons, in which the larvæ transform to the pupal stage. In hibernation the larva remains throughout the winter in the cocoon, in a state of quiescence, pupating early the following spring.

The pupal stage usually lasts from 5 to 10 days before the issuance of the mature insect, making the life cycle, under good conditions of temperature, from 4 to 5 weeks and affording opportunity for from 4 to 7 broods or generations of larvæ in one year. As the female is capable of depositing from 300 to 400 eggs, it may be seen that the capacity for injury is considerable.

## NATURAL ENEMIES.

This insect has a number of natural enemies, the most prominent being two hymenopterous parasites, *Omorgus frumentarius* Rond. and *Hadrobracon hebetor* Ashm. These two forms do much to check the multiplication of this and other similar pests.

## REMEDIAL MEASURES.

Although at first sight this insect seems to present a problem to the packer, its control is by no means so difficult as might be supposed. At least two effective methods of control are applicable, namely, heat and fumigation.

*The heat method of control.*—The treatment by heat, while new in its application to entire buildings, has during the past two years been

[1] The description of stages and notes on the life cycle are compiled largely from the work of Dr. F. H. Chittenden, published in Bulletin 1, new series, of the Bureau of Entomology, United States Department of Agriculture.

used very successfully, both in the control of the Indian-meal moth and in that of the related Mediterranean flour moth. Both Prof. G. A. Dean, of the Kansas Agricultural Experiment Station, and the author have used this method in the control of the flour moth, and it was used quite successfully by the latter in a peanut mill in Virginia. It is, of course, only applicable to mills heated by steam. In the proper application of this method the mill should be thoroughly piped and furnished with suitable radiators. Sufficient radiator surface should be supplied to obtain a temperature of 120° to 125° F. A few courses of 1¼-inch pipe placed along the side walls should easily bring about the desired results. If a warm day in the summer is selected and the steam is employed at a pressure of 75 to 100 pounds, only a small amount of radiator surface is needed. To permit the most effective penetration of the heat, the bags of nuts should be piled only a few feet deep, as experience has shown that some time is required for the peanuts within the piles to be raised to a uniform high temperature. The building should be closed tightly and the temperature raised to 120° F., remaining at this point for at least 6 hours. A longer time is advisable, as the penetration is thereby increased. Bags of shelled stock are with difficulty heated to the center without a long exposure, and although the larvæ work near the outside of the bags they may crawl to the center to escape the great heat, which tends to make them much more active.

The temperature should not be raised above 125° F. in the case of peanuts, as experiments have shown that a slight degree of blanching, or slipping of the "skin," takes place in shelled Spanish nuts exposed to such a heat. Virginia peanuts, being much less oily, are not affected, while no injury whatever takes place in the case of unshelled nuts. Germination is likewise unaffected, peanuts exposed 6 hours to a temperature of 140° germinating better and more quickly than those unheated. A temperature of 116° is fatal to insect life in a short time, larvæ, pupæ, and adults of the Indian-meal moth dying in less than one-half hour, when exposed.

*Fumigation.*—In mills and storehouses where the heat method is inapplicable, it may be necessary to fumigate with hydrocyanic-acid gas. *On account of the extremely poisonous nature of this gas care is necessary in its use*, and, where careless or ignorant help is employed, some danger might accrue through improper or careless handling. Before the gas is applied the building should be tightly closed; afterwards jars containing the requisite amount of diluted sulphuric acid should be placed therein, and the paper bags containing the cyanid of potassium dropped into these jars, thus liberating the gas in the room. This gas is used extensively as a remedy for flour-mill and household insects, and where intelligently handled

gives excellent results. Full directions for its use are given in Circular 112 of this bureau.[1]

Carbon bisulphid is also applicable as a fumigant, and is highly effective, although its great inflammability and the possibility of its explosion when ignited are in a measure against its use.

### MEANS OF PREVENTION BY THE PACKER.

In order to decrease the liability of peanuts to insect injury, the factory should be kept as free as possible from an accumulation of moths during the summer season. To this end, all cars of infested peanuts coming into the factory should be fumigated before entrance. The factories should be so constructed as to furnish as few hiding places for the larvæ and pupæ as possible. A modern reenforced concrete structure with concrete floors may be, with proper attention, kept almost entirely free from the pests.

The writer has seen large numbers of the larvæ hibernating between the two layers of a double floor that was apparently tight, and with ease resisting ordinary efforts to diminish their numbers. All cracks and crannies large enough to hold a small quantity of dust may also prove breeding places for the larvæ.

Care in attending to the freedom of outgoing freight cars from larvæ will also be of value in controlling the injury due to insects. An ordinary freight car can be easily and safely fumigated at a cost not to exceed $1, with either hydrocyanic-acid gas or carbon bisulphid. Even a thorough cleaning of the car before reloading will be of value in destroying many insects brought in with the previous shipment.[2]

The storage rooms should be light and airy, and the peanuts should not be piled so high that it is necessary to climb about on the bags in order to reach the top of the piles. While some degree of immunity may be reached by the storage of peanuts in large bulk, still the increased amount of breakage from this method more than balances the good effects of the bulk storage.

The storage of peanuts in elevator bins holding several thousand bushels each does not meet with this objection, as in such case the nuts are trampled but little, and the injury by insects is limited almost entirely to the top layer, rarely extending more than a foot or two below the surface.

### MEASURES OF PREVENTION BY THE GROWER.

Infestation of peanuts by the Indian-meal moth frequently takes place in the storage sheds or barns of the farmer or grower, where

[1] Circular 112, Bureau of Entomology, United States Department of Agriculture.

[2] Care should be taken that railroad agents deliver for peanut shipment only clean cars.

the nuts are held in reserve and only sold as needed. Where the nuts are held over the summer, the moths are allowed to breed freely, with the result that many nuts that would otherwise escape infestation are ruined. Storage in dark, dusty lofts or sheds also allows greater increase of the insects by providing a suitable breeding place. Nuts which have been held for several years by growers frequently show large numbers of infested kernels. It is urged in this connection that unless in exceptionally good condition with regard to broken shells, no nuts should be held in the granary of the farmer later than the 1st of June, at which time the injury by the first generation or "brood" is just beginning. When held later, without proper fumigation and attention, the multiplication of the pest is unchecked, with the result that the grade of the nuts is materially reduced.

Of primary importance is the proper selection and operation of the peanut picker or thrasher. There are several types of this machine on the market, which with careful use may be depended upon to break a minimum amount of the shells. The almost universal cause of such injury is the practice of crowding the machines in order to thrash a larger quantity of nuts in a short space of time. This practice is reprehensible, as it is responsible for the large amount of broken peanut shells found in machine-picked nuts. While more profitable to the thrasher, its expediency seems doubtful, as the grade of the nuts is thereby reduced and the opportunity for infestation increased, thus reducing the price obtained for the product. The peanut packer will readily pay a higher price for an article in which he can be assured of a maximum number of fancy nuts. It is therefore suggested that proper attention be paid to the operation of the picker, and that care be taken that the machine is not crowded. This will result in much less breakage and so diminish the infestation that there will be little need of further precaution in the matter of storage.